Lawrence J. Hoffman
Project Manager
Midwest Region

OHM Remediation Services Corp.

Direct Dial 419-425-6060
Facsimile 419-425-6087

September 9, 1994

Mr. Brad Bradley
United States Environmental Protection Agency
Region V
77 West Jackson
Chicago, IL 60604

RE: Pilot Test Results/Estimate
NL/TaraCorp Superfund Site
Granite City, Illinois
OHM Project 13407

Dear Mr. Bradley:

Attached is the Stabilization Pilot-Scale Testing Report for the slag pile on the NL/Tara Corp site. We have also enclosed a copy of the order-of-magnitude estimate to perform stabilization of the 125,000 cubic yards of lead-contaminated material from the soil, battery chips, and slag pile.

Please contact me with your comments.

Respectfully submitted,

Lawrence J. Hoffman
Project Manager
Midwest Region

LJH:bjc

pc: Mr. Jim McNulty, USACE

09/07/94
06:20 PM

ROM ESTIMATE FOR SLAG PILE STABILIZATION

Labor with fringes and overheads	$4,216,000.00
Equipment with fringes and overheads	$380,000.00
Lodging & Incidentals	$490,000.00
Supplies and Expendables	$3,733,000.00
Subcontracts	$4,800,000.00
PPE & Inventory Expendables	$360,000.00
Insurance	$61,000.00
Small Tools & Misc	$70,000.00
G&A, Facilities Capital Costs	$1,353,000.00
Subtotal	**$15,463,000.00**
Profit @ 10%	$1,546,300.00
Subtotal	**$17,009,300.00**
Contingency @ 15%	$2,551,395.00
TOTAL ROM ESTIMATE	**$19,560,695.00**

Basic Assumptions (Not All-Inclusive)

1) All three wastestreams (Battery Chips, Parking Lot Soil, and Slag Pile) total 124,000 cubic yards and will be blended proportionately during stabilization
2) 960 tons of treated materials produced per day
3) 254,000 tons of treated materials produced
4) A 15% (by weight) mix of portland cement for stabilization
5) Transportation and disposal based on materials as treated being non-hazardous
6) No bonding is included
7) Labor based upon Davis Bacon Wage Determination
8) Current 1994 OHM Costs utilized without escalation factors
9) Based upon activities required under previous USACE stabilization performed at the site

OHM Corporation

STABILIZATION PILOT-SCALE TESTING REPORT FOR LEAD-CONTAMINATED SLAG MOUND MATERIAL FROM THE NL INDUSTRIES/ TARRACORP SUPERFUND SITE, MADISON COUNTY, ILLINOIS

Prepared For:

U.S. Army Corps of Engineers
Omaha, Nebraska

Prepared by:

OHM Remediation Services Corp.
Findlay, Ohio

August 22, 1994
OHM Project 13407

Pilot-Scale Testing Objective

The objective of the stabilization pilot-scale testing on the lead-contaminated slag mound material from the NL Industries/Tarracorp Superfund Site in Granite City, IL, was to verify that the contaminated material in the slag mound was amenable to chemical fixation. The contaminated media under consideration is a combination of contaminated slag, pieces of lead, battery casings and chips, metal pieces, and soil associated with past battery salvaging practices at the NL Industries/Tarracorp site. The primary contaminant of concern is lead.

The remediation technology tested in this pilot-scale study is stabilization. Stabilization produces a solid of high structural integrity and reduces the hazard potential of a waste by converting the contaminants into their least soluble, mobile, or toxic form.

The objectives of the stabilization pilot-scale testing were to:

- Evaluate the suitability of the waste material for size reduction and stabilization,
- Determine the levels of reagents required for chemical fixation of the lead contamination in the waste material,
- Demonstrate compliance with anticipated regulatory requirements,
- Develop information on process design requirements for full-scale remediation.

The anticipated regulatory requirement for the remediation of the lead-contaminated soil material at the NL Industries/Tarracorp Superfund site is less than 5.0 mg/L leachable lead as measured by the TCLP (SW-846 Method 1311).

Contaminated Material

The contaminated material used in the stabilization pilot-scale testing was a composite of material excavated from the slag mound. The attached map indicates the position of the six excavation points within the slag mound. The contaminated material was comprised of slag, pieces of lead, battery casings and chips, metal pieces, and soil. Table 1 lists the approximate volume composition of the contaminated material, based on visual observation.

Table 1. Approximation of the Composition (By Volume) for Slag Mound Material

Component	% of Total Volume[a]
Slag	25
Pieces of Lead	20
Battery Casings and Chips	10
Metal Pieces	5
Soil	40

[a] Based on visual observation

Size-Reduction Activities

A Jeffrey Model 30 AB hammermill crusher was brought on-site and set up within the exclusion zone of the current stabilization operation. A 40-foot by 24-inch conveyor was set up to convey the contaminated material from the slag mound into the crusher. The stockpile of slag mound material, previously transported in the exclusion zone, was sorted to remove pieces larger than 18-inches. The sorted material was feed to the Jefferies at a rate of approximately 5 tons per hour. Water was sprayed on the material, as it moved up the conveyor, to reduce dust emissions.

The size-reduced material exited the crusher as a very dark soil-like material. Visually, less than 1% of the material exiting the crusher exceeded 1-inch in diameter and a majority of this was battery casing material. The size-reduced material appeared to be adequate for the stabilization pilot-scale testing. The bulk density of the size-reduced material was determined to be 1.55 tons per cubic yard.

Approximately 67 tons of size-reduced material was produced for use in the stabilization pilot-scale testing.

Stabilization Pilot-Scale Testing

Equipment

OHM's stabilization system consists of a variety of feeders, conveyors, silos, and a pugmill mixer integrated into a complete system for the continuous mixing of wastes and reagents. The contaminated soil is fed to a live bottom feeder and then by conveyor into the pugmill for blending with the stabilization additive. As the untreated material enters the pugmill, it passes over a weigh belt unit to record the tonnage of the material to be treated. The weigh belt provides a continuous record of the performance of the stabilization system. The stabilization additive material is introduced from the silo feeder which attaches to the pugmill. The silo feed rate is correlated with the weigh belt reading to ensure the appropriate ratio of stabilization additive is delivered to the pugmill in a consistent manner. The treated material is conveyed to a storage area for verification testing.

The pugmill mixer is 24 inches by 12 inches and is rated at 80 tons per hour capacity at 50 pounds per cubic feet. Based on an extended length configuration coupled with closely placed paddles, the pugmill optimizes mixing thoroughness through increased blade interaction with material. Paddles are bolted onto structural steel shafts with replaceable shafts flanged on both ends for ease of maintenance. The paddles are high carbon steel and heat treated welded at both ends. The mixer is V-belt driven by two motors with variable speed drives. Dust control is achieved in the pugmill by the use of a spray bar.

Portland cement is stored on-site in a vertical cement silo. The Portland cement used was Type I, obtained from a local supplier. The silo is self-leveling and has a capacity of 200 barrels of material. The silo is equipped with a top mount bag house for dust control during silo filling. The silo feed is controlled by an 8 inch diameter rotary screw feeder powered by a 3 horsepower motor. The motor speed is variable to control the addition of media to facilitate a process rate of 50 tons per hour.

Phosphoric acid was stored on-site in 55-gallon drums. The phosphoric acid used was 75% technical grade phosphoric acid obtained from Hargros Chemical. A diaphragm pump was used to feed the phosphoric acid into the pugmill mixer. The placement of the phosphoric acid feed line was along the water spray bar. The diaphragm pump was valved to deliver 5 gallons per minutes into the pugmill mixer.

Feed Rate Testing

Feed rate testing was conducted by running size-reduced material through the live bottom feed hopper and onto the feed conveyor. When a feed rate of less than 80 tons per hour was attempted for the size-reduced material, the live bottom feeder plugged, due to packing of

material in the feed hopper. Feed rates of 80 tons per hour or greater resulted in a consistent feed of size-reduced material, as the belt speed of the live bottom feeder was sufficeint to prevent packing of material in the feed hopper. It was decided to run the stabilization pilot-scale testing at a feed rate of 90 tons per hour.

Stabilization Testing

Five batches of stabilized material were run for varying lengths of time, processing at a feed rate of 90 tons per hour of size-reduced material. The processing parameters were recorded and presented in Table 2.

Table 2. Processing Parameters for the Stabilization Pilot-Scale Testing Batches

Batch	Feed Rate (tph)	Batch Size (tons)[1]	Estimated Batch Duration (min)	Cement Screw Frequency (Hz)	Cement Addition Rate[2] (tph)	Phosphoric Acid Addition Rate (gal/min)	Phosphoric Acid Addition Rate[3] (tph)	Amount of Treated Material Produced[4,5] (tons)
1	90	20.30	13.5	31	8.5	5.11	1.81	26.08
2	90	15.26	10.2	42	11.6	5.11	1.81	18.10
3	90	5.65	3.8	42	11.6	–	–	6.59
4	90	7.71	5.1	50	13.8	–	–	9.26
5	90	15.16	10.1	31	8.5	–	–	17.20

[1] Based on the feed conveyor scale
[2] Based on 0.2755 tph/Hz from calibration of screw feeder
[3] A density of 11.8 lb/gallon was used for the phosphoric acid
[4] Based on the exit conveyor scale
[5] Water was added as needed during treatment to control dust emissions

The treated material from each batch was stockpiled separately for total and TCLP leachable lead. The sampling consisted of compositing treated material from 3 points on the stockpile. The top 3-inches of the treated material was removed at each sampling point prior to obtaining the sample material. Two samples of the size-reduced material were also obtained in this manner. The analytical results for these samples are presented in Table 3 and copies of the analytical testing reports are attached.

Table 3. Total and TCLP Lead Results for the Stabilization Pilot-Scale Testing Batches

Batch	Portland Cement Mix Ratio[1]	Phosphoric Acid Mix Ratio	Total Lead (mg/kg)	TCLP Lead (mg/L)	TCLP pH
Untreated	--	--	208,000	979	5
Untreated	--	--	190,000	947	5
1	0.09	0.02	170,000	0.24	10
2	0.13	0.02	134,000	0.62	11
3	0.13	--	123,000	2.2	11
4	0.15	--	149,000	5.7	11
5	0.09	--	171,000	0.48	11

[1] Mix Ratio = [(Reagent Addition Rate (tph))/(Waste Feed Rate (tph))]

Conclusions

Composition of the Slag Mound Material

The contaminated slag mound material was comprised of slag, pieces of lead, battery casings and chips, metal pieces, and soil. Though the contaminated material was largely soil, sizable fractions of slag and lead pieces were also noted.

Size-Reduction of the Slag Mound Material

The visual observation that greater than 99% of the size-reduced material exiting the Jeffrey hammermill crusher was less than 1-inch in diameter indicates that the slag mound material is amenable to size reduction with common crushing equipment. The size-reduced material exited the crusher looking like a very dark soil-like material and appeared to be adequate for the stabilization pilot-scale testing.

For full-scale treatment of the slag mound material, the material should be screened prior to size-reduction activies to separate the soil from the material requiring size reduction. This will result in the more efficient use of the size-reduction equipment and increase the production rate of stabilization feed processing steps.

Processing of the Size-Reduced Material

The stabilization system that OHM currently has on-site was used to treat the size-reduced material. OHM's stabilization system consists of a variety of feeders, conveyors, silos, and a pugmill mixer integrated into a complete system for the continuous mixing of contaminated materials and reagents.

Feed rate testing on the size-reduced material suggested that a feed rate of less than 80 tons per hour resulted in plugging of the feed hopper. Feed rates of 80 tons per hour or greater resulted in a consistent feed of size-reduced material. The stabilization pilot-scale testing was conducted at a feed rate of 90 tons per hour.

The Portland cement used in the stabilization pilot-scale testing was Type I, obtained from a local supplier. The phosphoric acid used was 75% technical grade phosphoric acid obtained from Hargros Chemical.

Chemical Immobilization of Leachable Lead

The TCLP lead results for the two sample of the untreated, size-reduced slag mound material indicate that this material had extremely high levels of leachable lead. This was not surprising since the total lead content in this material is ~ 20% by weight.

The TCLP lead results for the treated material, reported in Table 3, indicate that the leachable lead can be chemically immobilized with the Portland cement or Portland cement/phosphoric acid reagent systems to below the anticipatory treatment level of 5.0 mg/L. However, the mix ratio of Portland cement used must be carefully monitored to maintain low leachable lead levels.

The solubility of lead as a function of pH follows a U-shaped curve when the pH exceeds 6. Initially, as the final equilibrium pH increases, the leachable lead level decreases. This decrease is due to the formation of lead hydroxide species, which have a minimum solubility in the pH range of 8.5 to 11. However, when the final equilibrium pH exceeds ~11.5, the leachable lead level increases. The increase is due to the formation of soluble lead-hydroxy anions at these high pH values.

The role of the phosphoric acid was to broaden the pH range of minimum solubility to the range of 7.0 to 11.5. The lead-phosphate-hydroxy species formed have a minimum solubility in this pH range.

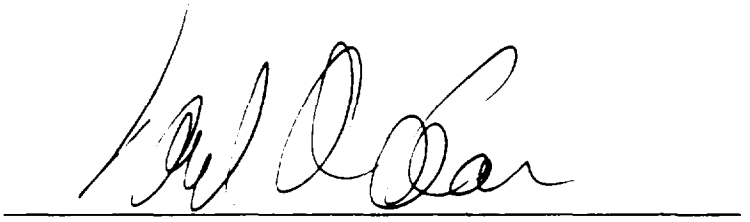
For the higher Portland cement mix ratios ($\geq$ 0.13), the final equilibrium pH in the TCLP extract must be ~11.5. This would cause the formation of soluble lead-hydroxy anions and result in increase leachable lead levels. When a 0.02 mix ratio of phosphoric acid is combined

with a 0.13 mix ratio of Portland cement, the presence of the phosphate forms lead-phosphate-hydroxy complexes which are only slightly soluble in this pH range and results in lower leachable lead levels.

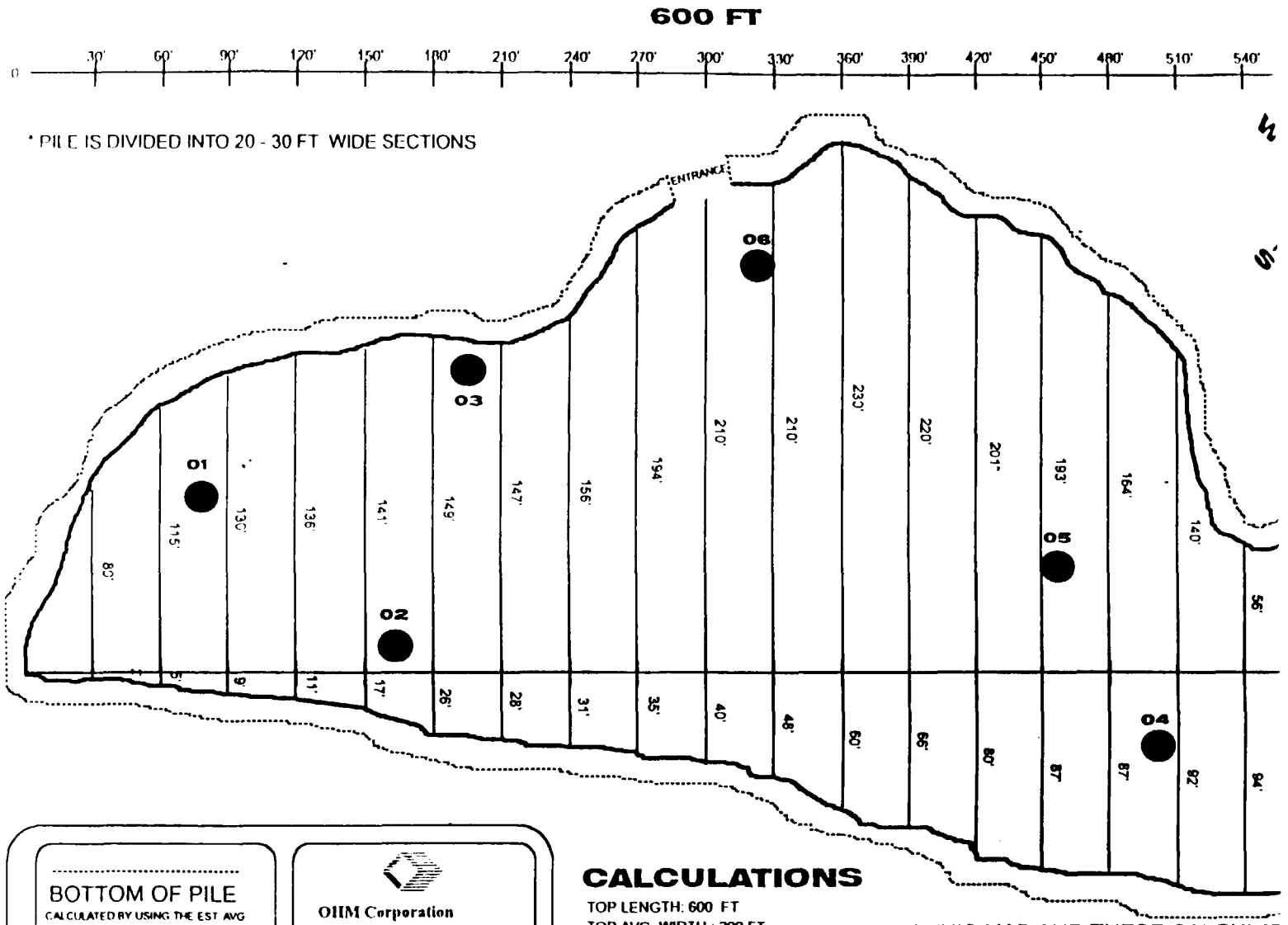
The TCLP results reported for the stabilized material indicate that a 0.09 mix ratio of Portland cement formulation or a 0.02 mix ratio phosphoric acid + 0.09 mix ratio Portland cement formulation would be suitable for the immobilization of lead in the slag mound material from the NL Industries/Tarracorp site. These formulations had the lowest leachable lead levels at the minimal reagent addition level.

Overall Conclusion

The slag mound material from the NL Industries/Tarracorp site appears amenable to remediation by stabilization. With the addition of screening and size-reduction equipment, the stabilization system that OHM currently has on-site was used to treat the slag mound material. A 0.09 mix ratio of Portland cement formulation or a 0.02 mix ratio phosphoric acid + 0.09 mix ratio Portland cement formulation would be suitable for the immobilization of lead in the slag mound material.



Paul R. Lear, Ph.D.
Manager, Treatability



BOTTOM OF PILE
CALCULATED BY USING THE EST AVG SLOPE OF 45 DEGREES

TOP OF PILE

SAMPLING POINT

OHM Corporation
Findlay, Ohio

Drawn By: RPR	Checked By:
Date: 7/26/94	Approved By:
Scale: 1 MM = 2.35 FT	Drawing No.

CALCULATIONS

TOP LENGTH: 600 FT
TOP AVG. WIDTH : 200 FT
TOP AREA : 13300 SQUARE YDS
EST. AVG. SLOPE: 45 DEGREES
EST. BOTTOM AREA: 16100 SQUARE YDS
EST. AVG. AREA: 14700 SQUARE YDS
EST. AVG HEIGHT: 10 YDS
EST. VOLUME: 147000 CUBIC YDS

* THIS MAP AND THESE CALCULAT
DO NOT INCLUDE THE SMALLER
WHICH ARE LOCATED TO THE S
OF THIS PILE. THE COMBINED
VOLUME FOR THESE SMALLER
5000 CUBIC YARDS

ENVIRONMENTAL CHEMICAL CORPORATION

QUALITY CONTROL

Customer:	O.H. MATERIALS CORPORATION	Cust. Proj. No:	13407
Location:	USACE - Granite City	Project No.:	19471
Analysis:	Lead	Date Received:	N/A
Method:	EPA 6010	Date Analyzed:	08/02/94
Prep Batch(s):	DIGSP0801	Lab Notebook:	421, Pgs 21-22
Inst. Batch(s):	ICP0802	Detection Limit:	2.9 mg/kg

LAB I.D.	CUSTOMER SAMPLE NO.	MATRIX	VALUE mg/kg
19471-001 DUP	RAW 1	SOIL	196000
Blank	N/A	SOIL	BDL

			Spike mg/kg	Recovered mg/kg	% Recovery
LCSS	N/A	SOIL	147	133	90%
19471-001 MS	RAW 1	SOIL	146	*	***%
19471-001 MSD	RAW 1	SOIL	146	*	***%

BDL - Below Detection Limit

* Spiked added is 4 times less than the sample amount.

ENVIRONMENTAL CHEMICAL CORPORATION

Customer:	O.H. MATERIALS CORPORATION	Cust. Proj. No.:	13407
Location:	USACE - Granite City	Project No.:	19471
Analysis:	Lead	Date Received:	08/01/94
Method:	EPA 6010	Date Analyzed:	08/02/94
Prep Batch(s):	DIGSP0801	Lab Notebook:	421, Pgs. 21-22
Inst. Batch(s):	ICP0802	Detection Limit:	2.9 mg/kg

LAB I.D.	CUSTOMER SAMPLE NO.	MATRIX	LOCATION	VALUE mg/kg
19471-001	RAW 1	SOIL	Brown Soil + Chips from Raw Pile	208000
19471-002	RAW 2	SOIL	Brown Soil + Chips from Raw Pile	190000
19471-003	BATCH 1	SOIL	Brown Soil; Batch Pile #1	170000
19471-004	Batch 2	SOIL	Brown Soil; Batch Pile #2	134000
19471-005	Batch 3	SOIL	Brown Soil; Batch Pile #3	123000
19471-006	Batch 4	SOIL	Brown Soil; Batch Pile #4	149000
19471-007	Batch 5	SOIL	Brown Soil; Batch Pile #5	171000

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Co./Dept. OHM		Co. ECC	
Phone #		Phone # 752-2750	
Fax #		Fax # 752-2261	

ENVIRONMENTAL CHEMICAL CORPORATION

Customer:	O.H. MATERIALS CORPORATION	Cust. Proj. No.:	13407
Location:	USACE - Granite City	Project No.:	19471
Analysis:	pH AFTER LEACHING	Date Received:	08/01/94
Method:	EPA 9041	Date Analyzed:	08/03/94

LAB I.D.	CUSTOMER SAMPLE NO.	MATRIX	LOCATION	RESULTS
19471-001	RAW 1	TCLP EXTRACT	Brown Soil + Chips from Raw Pile	5
19471-002	RAW 2	TCLP EXTRACT	Brown Soil + Chips from Raw Pile	5
19471-003	BATCH 1	TCLP EXTRACT	Brown Soil; Batch Pile #1	10
19471-004	Batch 2	TCLP EXTRACT	Brown Soil; Batch Pile #2	11
19471-005	Batch 3	TCLP EXTRACT	Brown Soil; Batch Pile #3	11
19471-006	Batch 4	TCLP EXTRACT	Brown Soil; Batch Pile #4	11
19471-007	Batch 5	TCLP EXTRACT	Brown Soil; Batch Pile #5	11

ENVIRONMENTAL CHEMICAL CORPORATION

QUALITY CONTROL

Customer:	O.H. MATERIALS CORPORATION	Cust. Proj. No.:	13407
Location:	USACE - Granite City	Project No.:	19471
Analysis:	Lead	Date Received:	N/A
Method:	EPA 6010	Date Analyzed:	08/03/94
Prep Batch(s):	DIGT0802	Lab Notebook:	421, Pg. 23
Inst. Batch(s):	ICP0803	Detection Limit:	0.15 mg/L

LAB I.D.	CUSTOMER SAMPLE NO.	MATRIX	VALUE mg/L
19471-001 DUP	RAW 1	TCLP EXTRACT	1210
Blank	N/A	TCLP EXTRACT	BDL

			Spike mg/L	Recovered mg/L	% Recovery
LCSS	N/A	TCLP EXTRACT	0.50	0.44	88%
19471-001 MS	RAW 1	TCLP EXTRACT	1.0	*	***%
19471-001 MSD	RAW 1	TCLP EXTRACT	1.0	*	***%

BDL - Below Detection Limit

Spike added is 4 times less than sample amount.

ENVIRONMENTAL CHEMICAL CORPORATION

Customer:	O.H. MATERIALS CORPORATION	Cust. Proj. No.:	13407
Location:	USACE - Granite City	Project No.:	19471
Analysis:	Lead	Date Received:	08/01/94
Method:	EPA 6010	Date Analyzed:	08/03/94
Prep Batch(s):	DIGT0802	Lab Notebook:	421, Pg. 23
Inst. Batch(s):	ICP0803	Detection Limit:	0.15 mg/L

LAB I.D.	CUSTOMER SAMPLE NO.	MATRIX	LOCATION	VALUE mg/L
19471-001	RAW 1	TCLP EXTRACT	Brown Soil + Chips from Raw Pile	979
19471-002	RAW 2	TCLP EXTRACT	Brown Soil + Chips from Raw Pile	947
19471-003	BATCH 1	TCLP EXTRACT	Brown Soil; Batch Pile #1	0.24
19471-004	Batch 2	TCLP EXTRACT	Brown Soil; Batch Pile #2	0.62
19471-005	Batch 3	TCLP EXTRACT	Brown Soil; Batch Pile #3	2.2
19471-006	Batch 4	TCLP EXTRACT	Brown Soil; Batch Pile #4	5.7
19471-007	Batch 5	TCLP EXTRACT	Brown Soil; Batch Pile #5	0.48

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